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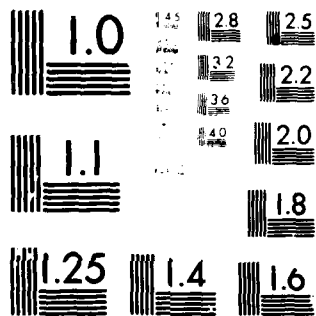
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Report No. 4399

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Combined Quarterly Technical Report No. 17

**SATNET Development and Operation
Pluribus Satellite IMP Development
Remote Site Maintenance
Internet Development
Mobile Access Terminal Network**

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May 1980

**Prepared for:
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Report No. 4399

Bolt, Beranek and Newman Inc.

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COMBINED QUARTERLY TECHNICAL REPORT No. 17.

SATNET DEVELOPMENT AND OPERATION
PLURIBUS SATELLITE IMP DEVELOPMENT
REMOTE SITE MAINTENANCE
INTERNET DEVELOPMENT
MOBILE ACCESS TERMINAL NETWORK.

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1. INTRODUCTION

This Quarterly Technical Report is the current edition in a series of reports which describe the work being performed at BBN in fulfillment of several ARPA work statements. This QTR covers work on several ARPA-sponsored projects including 1) development and operation of the SATNET satellite network; 2) development of the Pluribus Satellite IMP; 3) Remote Site Maintenance activities; 4) internetwork monitoring; and 5) development of the Mobile Access Terminal Network. This work is supported under contracts MDA903-76-C-0252, N00039-78-C-0405, MDA903-80-C-0353, and N00039-79-C-0386 and is described in this single Quarterly Technical Report with the permission of the Defense Advanced Research Projects Agency. Some of this work is a continuation of efforts previously reported on under contracts DAHC15-69-C-0179, F08606-73-C-0027, F08606-75-C-0032, and MDA903-76-C-0213.

2. SATNET DEVELOPMENT AND OPERATION

2.1 T&M Problem

Problems with the the transfer of T&M data to the Satellite IMP have occupied a large share of our time during the last quarter. The current situation with this function at the individual SATNET sites is: the Tanum site has yet to receive a PSP terminal, without which no T&M data is generated; the Goonhilly Satellite IMP has never been successful in commanding the CMM of its PSP terminal in order to enable the transfer of T&M data from the PSP terminal to the Satellite IMP (CMM commands from the Satellite IMP fail to echo, which indicates that the commands are ignored); the Clarksburg site has not been a participating member of SATNET since the beginning of December due to transmitter refurbishing; and the Etam site appears to have a fundamental problem with the transfer of T&M data to the Satellite IMP.

The T&M problem manifested at Etam is that the site fails to receive about 10% of its own Hello packets, due primarily to hardware checksum errors when T&M is enabled and when other stations are on the regular SATNET channel. Concurrently, Etam receives all of Goonhilly's and Tanum's Hello packets correctly, and Goonhilly and Tanum receive all Hello packets from all three sites correctly.

To determine where packets with incorrect checksums have been altered, we patched the Satellite IMP to crash upon receipt of one of these damaged packets. Once the Satellite IMP crashed, we searched memory buffers to examine the packet in detail. The results of these searches are given below.

- In almost all cases of packets received with hardware checksum errors but good header checksums, the packets were verified to be short; i.e., fewer words than indicated by the packet length in the header were transferred into memory by the DMA. (We trust the packet length in the header because the header checksum is valid.)
- In several cases, Hello packets were received with the last two T&M words missing, with an incorrect hardware checksum, and with a correct header checksum. The packet failed the Satellite IMP hardware checksum test because the hardware checksum indicator is carried in the missing 4th T&M word.
- In one case, a stream packet from Goonhilly destined for Tanum (part of the ARPANET direct connection via SATNET, line 78) was received with four words missing, with an incorrect hardware checksum, and with a correct header checksum. Since we could not determine what the original data were supposed to be, we could not assert that T&M data only were missing and not packet information.

All considered, we were unable to find a revealing pattern of failure among these damaged packets.

Further tests have shown that the problem disappears at the Etam and Clarksburg sites when they are crosspatched at their modem outputs while T&M data are appended to the packets. Also, the problem disappears when Etam is transmitting by itself on the test channel. Correctness of the T&M data in these situations has yet to be determined by Comsat. In the tests at Clarksburg, the Satellite IMP was temporarily connected to the Tanum PSP terminal, so as to provide access to T&M data. Subsequently, the PSP terminal was shipped to Tanum and is no longer available for testing. Since the UET terminal as of this time is incapable of generating T&M data, the Clarksburg site can provide no more insight into the problem.

While conducting the above tests, we were made aware that the PSP terminal design was never supposed to provide T&M data when in any crosspatch mode which excludes the modem. What this means operationally is that any time the PSP terminal is placed into data crosspatch mode, the Satellite IMP must first issue the disable T&M data transfer command to the CMM to prevent the Satellite IMP from attempting to process absent data.

Since a loss of as many as four words in the packet has been seen, we performed experiments equivalent to increasing the guard

times to verify whether the problem is resulting from insufficient time to transfer the data to the Satellite IMP. For reference, last year at this time the guard time was 260 microseconds. When the Satellite IMP was plagued by the extra SYN problem last fall, we increased the guard by another 260 microseconds to accommodate the increased number of bits. Subsequently, the extra SYN was eliminated through a hardware modification of the Honeywell 316 modem interface cards. Later, when the PSP terminal was installed, the preamble was reduced by Comsat from 60/60 (carrier sync/bit sync) channel symbols to 32/64 channel symbols, a reduction of 750 microseconds. Since the preamble was expected to change again with the introduction of PSP terminals in all sites, the interpacket gaps specified by the Satellite IMP program were not altered to reflect the new situations; hence, interpacket guard times increased by that amount to a current total of 1.27 milliseconds. This figure seems more than ample, but to settle the question of whether the guard time is sufficient, we made the following tests.

First, T&M was enabled at Etam, which began losing 10% of its own Hello packets due to hardware checksum errors. Next, Goonhilly was placed into its loader/dumper program. Since the transmission order of Hello packets is Etam, followed by Goonhilly, followed by Tanum, followed by Clarksburg, the net effect is to place a 10 millisecond gap between Etam's Hello

packet and Tanum's Hello packet, equivalent to increasing the guard band between the two by 10 milliseconds. The results were identical to those above; Etam continued to lose 10% of its Hello packets due to hardware checksum errors, no matter whether Etam's Hello packet was first, second, third, or fourth. With these results, we concluded that the interpacket guard times were not the cause of the problem.

2.2 Software Problems Fixed

We found a bug in the synchronization code which was able to prevent the Satellite IMP from achieving reservation synchronization during particular traffic patterns on the satellite channel. The cause of the problem was due to the dummy scheduling algorithm ignoring all reservations arriving in the remainder of the PODA information subframe after the central scheduling queue QC emptied. The reason the bug did not surface earlier is that in normal field operations, the traffic is low enough that no reservations will arrive after QC empties and before the control subframe begins. Similarly, in normal test operations, the channel is either overloaded, in which case QC never empties, or underloaded, in which case no reservations will arrive after QC empties and before the control subframe begins.

The fix to the bug requires that when QC is empty, the dummy scheduling algorithm moves into QC from the reservation queue QR

those entries which have been received before the control subframe begins. Dummy scheduling then proceeds as before on a nonempty QC. To ensure adequate scheduling time among all sites, the first entry on QC is scheduled for the reservation received time plus one virtual slot as its dummy scheduling time.

2.3 Hardware Problems Fixed

During the last quarter several hardware problems appeared, which we diagnosed and, when related to the Honeywell 316, fixed. A miswiring on the Clarksburg Honeywell 316 modem interface boards interfered with the data transfer between the Satellite IMP and the UET terminal. A memory failure problem at the Clarksburg Satellite IMP and a terrestrial line noise problem at the Etam Satellite IMP were traced to Honeywell 316 power supply voltages which had drifted outside of nominal range.

We participated in the discovery of several problems with the power supply on the PSP terminal at Etam; Comsat traced the first to a defective voltage regulator and the second to failed capacitors.

When a failure occurred in the circuit between the Comsat gateway and the Clarksburg Satellite IMP, it was originally thought that the ACC VDH interface module had failed as it had previously this year, since both the Honeywell 316 and the PDP-11 diagnostics were successfully run. Diagnostics on the ACC

hardware were not available at the time. The failure was finally traced to a defective power supply in the modem eliminator between the Satellite IMP and the gateway. The modem eliminator was replaced and the problem disappeared. We have since arranged to have ACC hardware-diagnostics software available at Comsat for immediate use to check the VDH hardware.

3. PLURIBUS SATELLITE IMP DEVELOPMENT

During the last quarter, the Host-Access Protocol definition was further solidified. Section 3.1 summarizes its current state. Section 3.2 describes a stand-alone TENEX/TOPS-20 program which produces a graphical representation of satellite channel activity from data reported to EXPAK. Below are summarized the progress with the implementation of the Host-Access Protocol, the implementation of a terrestrial landline loader/dumper, and the satellite modem interface boards. In addition, a significant milestone was passed with the first Pluribus Satellite IMP (PSAT) prepared and shipped from BBN and installed at Lincoln Laboratory.

Major accomplishments during the last quarter concerning the Host Access Protocol Module are the implementation of the the link restart procedure and the acceptance/refusal (A/R) mechanism, both of which are described in W-Note 4. As described, link restarts are performed upon the receipt of a restart message; afterwards, a message is sent out to indicate restart completion. When done, the circuit statistics between the two sides are synchronized.

At present the A/R decision is strictly local; network wide decisions will be designed later, when more experience is gained with network operation. Testing of the A/R mechanism was done by

connecting two PSATs via a local host connection and using internal message generators to generate traffic at high rates. Because of the symmetry of the Host-Access Protocol, each PSAT looks like a real host to the other PSAT; hence, traffic can be sent in either direction by enabling the message generator in the appropriate PSAT.

To guard against the situation where buffers are unavailable for host traffic, we implemented a mechanism which checks the queue size during enqueueing and limits the queue to a maximum size. In particular, we modified the Enqueue and the Dequeue procedures so that procedures which manipulate queues with Enqueue and Dequeue can now limit the maximum queue size. This feature provides rudimentary resource level flow control to take effect whenever the PSAT accepts traffic faster than it can send. Since the transmit and receive sides of the local host hardware interface may run at slightly different rates, queue limitation is necessary when running loopback tests between two PSATs to prevent memory buffers from being over-allocated.

The terrestrial line loader/dumper, a stand-alone Pluribus program which provides the user the capability to load, dump, verify, and debug PSATs remotely, was finished. The program is currently being used by the PSAT programmers for access to PSATs via the ARPANET.

Implementation required building an interface to packet core routines in the Pluribus operating system (Stage), building a device discovery module, and modifying packet core so that it recognizes Internet Protocol. The standard ARPANET utility (U) program was also modified to be able to handle Internet Protocol with Pluribus machines.

A large amount of time was spent modifying and debugging the boards of the Satellite Modem Interface (SMI) so that it will be able to send multi-packet bursts at 3 Mb/s. The results of our latest tests indicate that the modifications were successful and that the SMI hardware is indeed capable of operating at 3 Mb/s. (Note, however, it has yet to be verified whether the PSAT has enough computational bandwidth to operate at 3 Mb/s.)

The SMI contains three special purpose boards and one standard DMA board. The three special purpose boards, designated as a transmit board, a receive board, and a timing board, were the ones that were modified. In particular, the transmit board was rewired to handle multi-packet bursts at the high rate. The receive board was rewired to increase the packet length field from 8 bits to 12 bits. On the receive board, the PROMs, which define the finite state machine for the line protocol, were changed to enable high rate operation. The timing board was also changed as a consequence of changes made to the transmit board; namely, control bits on each were redefined for multi-packet operation.

3.1 Host-Access Protocol Definition

The following subsections summarize the Host-Access Protocol (HAP) definition as of April 25, 1980. It is based upon W-Note 4 and subsequent meetings held on January 27 and March 24, 1980. Details and formats will be provided at a later time.

3.1.1 Message Level

Error Control

Satellite Channel:

- Choice of several reliability levels will be provided.
- "Data error delivery" bit (host to PSAT) defined.
- "Data errors detected" bit (PSAT to host) defined.

Host - PSAT Link:

- All HAP message headers and control messages (level-3) have software checksum (discard if bad, no retransmission).
- No link error control on data to be implemented in initial system since remote connections may use HDLC or equivalent at level-2.

Flow Control

- Selective acceptance/refusals (non-blocking) defined.
- A/R's (acceptance/refusals) may be turned off for "pure discard" interface.
- UR's (unnumbered refusals) are returned for certain conditions in "pure discard" interface.
- Acceptable priorities ("GOPRI") are passed periodically.
- Additional rate-oriented flow control information may be added later after internal network flow control is well-defined.

Link Monitoring

- Host and PSAT will exchange counts of messages sent and received, number of errors, etc., in periodic status messages (about once per second).
- Counts are exchanged in a manner which allows either side to determine error and discard statistics for both directions.

Multilinking

- The use of two or more physical links to increase host-PSAT bandwidth and/or reliability will be done at the level-3/level-4 interface (i.e., each link will have separate flow control exchanges, monitoring, and restarts).

Port Expansion

- Port expansion will be provided by a level-2 header containing local addressing information in chip-compatible format.
- Port expansion will be handled as 'local port configuration' by PSAT as required, allowing other level-2 formats (e.g., HDLC) when needed.

Max Message Size

- Maximum message size will be 16,384 data bits (2^{14}) plus up to 400 bits of control information at level-3 and above.

Time to Live

- Four choices of time to live (aka 'holding time') will be provided with values to be determined; a different set of values may be used for stream messages.

Inter-Arrival Time Control

- A pause mechanism will be used to introduce a constant elapsed time following the end of each output transfer before a new transfer can begin; pause value is to be tuned manually (initially) for each end of link.

3.1.2 Setup Protocol

- Setup protocol operates on top of message level (i.e., a level-4 protocol); all setup messages have software checksums.
- Hosts send request messages (i.e., create, delete, join, leave, change) to the service host (address "zero") in the local PSAT.
- The PSAT returns a reply message in response to a request message; if a reply is not immediate, the PSAT also sends an ack message.
- The host returns an ack in response to a correctly received reply.
- The PSAT also sends a notification message to the host for certain events (e.g., 'stream deleted'); the host returns an ack.
- Internet setups are supported as in SATNET (i.e., internet headers are used in request/reply messages, and no internet notifications are sent).

3.1.3 Streams

- Hosts deal with 'host streams', whereas PSATs may combine two or more host streams originating at the same site for channel scheduling purposes ('channel streams').
- Initially, only simplex host streams (one source host per stream) will be supported; 'shared streams' (two or more source hosts and host-level coordination) may be supported at a later date if required.
- A choice of several 'powers-of-two' stream interval sizes will be provided; initially the choices will be 1, 2, 4, or 8 PODA frames (where a PODA frame will be either approximately 20ms or 40ms, to be determined).
- Messages sent in a particular host stream may be addressed to any destination (including groups); also, more than one message may be passed to the PSAT for transmission in the same stream slot; i.e., the PSAT will concatenate distinct messages. (Note: this is a change from the 'single

address/no concatenation per host stream' solution proposed in W-4, and has been made to allow more effective traffic multiplexing by hosts in each host stream.)

- Stream priority (P), interval (I), reliability (R), and slot size are defined by the host in the stream setup message. Each distinct set of values of the first three of these parameters (P,I,R) defines a unique host stream. A unique 7-bit stream identifier will be assigned by the PSAT at setup time, and must be sent by the host in the Type-of-Service (TOS) field of each data message sent in the stream. (Note: the 7-bit identifier is a change from what was described at the March Wideband meeting.)
- The specification of stream slot size must take into account the number of distinct messages the host expects to send in a single stream slot, as well as the maximum message size and 'reliability length' for the control portion of messages. Details of this specification are to be determined.
- The stream slot size must also take into account whether a stream destination is attached to a PSAT operating at a reduced channel receiving rate (a low-rate site, or LRS). This will, in general, involve resource negotiation mechanisms which are still to be worked out. The presently defined approach calls for the requesting host to optionally supply a list of destination addresses to the PSAT, allowing the latter to identify any associated with an LRS. (The initial implementation will assume that all sites receive at the same rate.)
- A rapid-change stream slot size capability may be added at a later date, pending further study (at present, slot size may be changed, along with any other stream parameter, only by use of the setup mechanism).

3.1.4 Group Addressing

- A group address is established by a setup request from a host, which automatically becomes a member of the group; additional members must be established by use of the distributed join/leave mechanism following distribution of the group address by the host to the other desired members (i.e., top-down binding).

- To prevent membership confusions from arising following a host or PSAT crash recovery, the PSATs also assign a 48-bit key along with the group address. The key must be distributed along with the address to all hosts which are to become members, and is supplied by the hosts in join/leave and delete messages.
- A group address can be deleted by a delete request from any member host. In addition, a group address will automatically be deleted by the PSATs if it is not used for an elapsed (to be defined) time (this time will probably be long compared to stream lifetimes, e.g., hours or days, depending on the availability of unassigned address space).

3.1.5 Notifications

- PSATs will send notification messages to appropriate hosts whenever a group address of which they are a member is deleted, or whenever one of the hosts' streams is suspended, resumed, or deleted due to resource availability changes.

3.2 SCOPE

SCOPE is a TENEX/TOPS-20 program to produce graphical representations of satellite channel activity from data reported to EXPAK. Program operation, which is modelled after that of an oscilloscope, allows users to specify time delays, trigger events, trace length, and resolution. The information is displayed as one to five lines of "trace", with status lines to indicate collection site, frame number, and the value of user-settable parameters.

SCOPE is significantly more powerful and flexible than EXPAK's Channel Trace facility developed for SATNET. Although intended for use with all of the satellite networks (PSAT,

SATNET, and MATNET), its actual use with the latter two awaits changes in the SATNET Satellite IMP program.

SCOPE, while currently terminal independent, is designed as if the user's terminal were a CRT terminal. The TENEX/TOPS-20 terminal mode should be set to type 0 (printing TTY), and the LENGTH and WIDTH commands should be set to the screen width and page length (typically 24 X 80 for CRT terminals). If a hard-copy terminal is used, INDICATE mode should be set. SCOPE will read the page length and width when it starts up and will keep trace lines small enough to fit. Until we change to the Rutgers supplied PASCAL compiler recently installed at BBN, the symbol "!" will be used instead of the symbol "|" for a packet delimiter, and lower case letters will be converted to upper case letters on output. On input, the program has been written to accept either case.

There are three principal things printed out by the program: Status Line 1 (at the top of the screen), Status Line 2 (at the beginning of each frame), and the channel trace itself (which may be up to five lines long). Each is described, along with sample printouts, in detail in the next sections.

3.2.1 Status Line 1 Display

Delay1	Triggers	Delay2,	Window	Resolution	Filters
210 uS	<OFF>	-40 uS,	21.9 ms	(171 bits/char)	<FILTERED>

Delay1. This represents the length of time that must pass from the beginning of the frame before the trace can begin. Channel trace data representing bursts that BEGIN before this delay time will be skipped over.

Triggers. This will be one of <Off> <Any> or <Triggered>. If triggering is disabled, <Off> will be printed. If triggers are enabled, but the first pattern is one that matches all sites and all burst types, then <Any> is printed. Otherwise <Triggered> is printed. Triggering will not occur until after Delay 1 has passed. The trigger is considered to occur at the beginning of the first burst whose source and type meet the triggering tests.

Delay2. This number is the time forward or backward from the trigger event, or the end of Delay 1 if no triggering, to the beginning of the trace. In the example above, the trace is to begin at $210 - 40 = 170$ microseconds after the start of the frame. This delay will not back up past the beginning of the frame.

Window (size). This is the length of time represented by the trace. In the example, the trace is 21.9 milliseconds long.

Resolution. This value indicates the resolution of the trace in terms of bit-times per character position. For a trace length of 21.9 milliseconds, using five lines of trace printout at 79 characters per line, this would be $21.9 \text{ ms} / (5 * 79)$ or 55.5 $\mu\text{s}/\text{char}$. In the PSAT network, where there are 3.088 bits/microsecond, this becomes 171 bits per character position.

Filters. This will be either <ALL> if the first filter passes all sites and all burst types, or <Filtered> otherwise.

3.2.2 Status Line 2 Display

Net	Site	Time/div	Frame	Interval	Parameter
PSAT:	ISI	500 $\mu\text{S}/+$	Frame #E0	+214 μS	>>Delay 1

Net. Either SATNET or PSAT.

Site. Name of site sending trace information.

Time/division. The "time-line" part of a trace printout has periodic division markers, like "---+-----+---". The time per division is the time between successive plus signs.

Frame. This is the frame number as reported by the collecting site. This number, from 0 to 255, is printed in hexadecimal for the PSAT network and in octal for the SATNET network.

Interval, or trigger delay. This item is displayed only when triggering is enabled. Since triggering causes an indeterminate delay, this number is printed to indicate the time from the beginning of the frame until the actual beginning of the trace displayed.

Parameter. This indicates which of the program parameters is currently being selected for changing upon request from the user.

3.2.3 Trace Line Display

```

I..!   I.....!   DL!
L..!   C.....!   QH!
+-----S-----+-----+-----+-----+-----

```

Top line: Burst source.

Second line: (and sometimes third line): Burst type.

Third line: Time line.

The example shows four bursts. They are:

Leader packet (L) from ISI (I);
 Centralized Stream (CS) from ISI (I);
 Query packet (Q) from DCEC (D);
 Hello packet (H) from Lincoln (L).

Information in status lines 1 and 2 would indicate the time per division and the time per character position. In terms of characters, the example packet lengths are 4, 12, 1, and 2.

If the resolution chosen is large enough, more than one packet may fall at the same character position. If this occurs,

the program will attempt to make small adjustments to the printout to retain as much information as possible in the display. If an adjustment cannot be made, then the symbol "*" will be printed on the top line to indicate more than one packet at that character position.

4. REMOTE SITE MAINTENANCE

4.1 Remote Operations

BBN received permission to operate on the Advanced Command and Control Architectural Testbed (ACCAT) classified sub-net in late January 1980. The first contact was made over the network on February 15, 1980. Since that time, arrangements have been made to have regular contacts with the Remote Site Module (RSM) at the Naval Ocean Systems Center (NOSC). These contacts are now made on Friday of those weeks in which NOSC operates on Friday, and Thursday of the other weeks. This arrangement has allowed BBN to transfer dumps from NOSC to Cambridge, along with certain other information which is needed for the analysis of the dumps.

4.2 Multiple File Transfers

The installation of new or revised commands, or of the operating system, usually requires the transfer of more than a single file. The ordinary implementation of the File Transfer Protocol (FTP) is single file oriented. During the past six months, BBN has been developing extensions of this protocol which can be effectively used for transferring a number of files. An experimental implementation of this augmented FTP is now in operation on BBN-UNIX and at the other RSMs. An RFC for these additions is in preparation, and will be submitted during the next quarter.

Initially, a version of FTP was prepared which simply stored a group of files which were specified using the UNIX wild-card conventions. These files would then be stored at a single directory level in the remote host. Since it is as easy to manipulate a directory as an ordinary file in the UNIX system, it seemed desirable to expand the FTP servers to include commands which deal with the creation of directories. Furthermore, since other hosts on the ARPANET have operating systems which support tree-structured directories, the commands for manipulating directories should be defined with these systems in mind, particularly TOPS20 and MULTICS.

The proposed additions are as follows.

XMKD child

Make a directory with the name "child".

XRMD child

Remove the directory with the name "child".

XCUP

Change to the parent of the current working directory.

The directory which is created or removed is a subdirectory of the current working directory, unless the string contains sufficient information to specify otherwise to the server, for example, an absolute pathname in the UNIX remote host.

The XCUP command is a special case of CWD. It is particularly useful when one is transferring directory trees between hosts using different operating systems. It frees the store/retrieve programs from a need to understand the details of the file naming syntax on the remote host.

4.3 Graphics System Library and Documentation

Only limited documentation has been available for the graphics subsystem of the Remote Site Module. In addition, the relatively large number of subroutines which have been available for this subsystem have not previously been organized as a UNIX archive. As a result, the development of consistent new software at BBN and elsewhere has been impeded. During the past quarter, new or improved documents have been prepared on the following commands.

The Genisco micro-code assembler, `gasm3`, which assembles the given files, puts a listing on the standard output and the object code in the file `g.out`.

`Gld3` loads a program which has been previously assembled by `gasm3` into the Genisco PGP (Programmable Graphics Processor).

`Pgp3` is used to obtain or set the current status of a Genisco display system processor.

Storepic and restorepic dump the picture data from a genisco bit-map display onto a disk file, or restore it from the disk file to the display memory.

In addition, documentation of the hardware at a level appropriate for users and programmers has been prepared. This is supplemented by a complete description of the available device drivers for the Genisco, and the procedures for configuring these drivers for a particular application.

The main graphics library assembled for the Genisco includes the following elements.

Initialization routines:

usefile - initialize output stream
loadvlt - load video color table location with R,G,B value
ntdsfile - open an NTDS character definition file

Environment routines:

plselect - select active graphic memory planes
colset - set the current color
fillit - select planes for fill mode and VLT gating
t_set - low level memory plane environment routine

Drawing routines:

absmove - move the cursor position to an absolute location
absvec - draw a vector to an absolute location
relmove - move the cursor position to a relative location
relvec - draw a vector to a relative location
text - draw a text string
ntdsym - draw a character from the NTDS file
plset - write this color into every screen pixel
t_dabs - low level absolute coordinate routine
t_drel - low level relative coordinate routine
t_putve - low level vector drawing routine
t_vterm - low level vector termination routine

I/O routines:

send - flush output stream
gclose - terminate output stream

5. INTERNET DEVELOPMENT

During the last quarter, we made substantial additions to the CMCC program; these are detailed in section 5.1. Section 5.2 describes the equipment for two facsimile systems, which we have ordered, and which have mostly arrived at BBN. Below is summarized the current status on the VAN gateway and the LSI-11 SATNET gateways.

The 1.2 Kb/s dial-up modem has been installed at BBN. We currently are writing software for testing the bisync and HDLC connection to the TELENET test-TIP at Vienna, Virginia.

We checked the bus converter operation with the LSI-11 gateway and the PDP-11 ACC VDH interface by operating the VDH interface diagnostic software in the LSI-11. Subsequently, gateway software ran successfully in the LSI-11 for a brief test.

5.1 CMCC Development

The CMCC program was modified to use internet queue JSYSs and to recognize the TOPS-20 end-of-line character, so as to permit operation on TOPS-20 hosts. The program has been installed in the directory CMCC at ISIE and is currently available for usage by the entire catenet community.

During the last quarter, we added the following new features to the CMCC program:

- program auto-start operation,
- gateway report-restart,
- report filtering,
- gateway polling,
- new display command format,
- new report formats,
- last-time heard response.

These features provide the following functions.

The display process was modified to permit auto-start operation; namely, when the process is started up detached, it will automatically begin logging data for a permanent record of catenet operation. Currently we are logging traps, gateway traffic reports, and gateway routing reports.

The gateway report-restart mechanism allows gateways that have crashed and restarted to continue reporting in the same fashion as before the crash. The gateway is not expected to remember the reporting parameters, so this role is performed in the CMCC.

Report filtering is the mechanism whereby the CMCC terminal process outputs only that fraction of the number of reports coming in which corresponds to the user specified output interval. Extra reports are discarded. This mechanism allows the CMCC program to display and to log traffic reports and routing reports at longer intervals than can be specified in the gateways themselves. (Because of a limitation in the interval counting mechanism implemented in the gateways, regular reports

cannot be sent any less frequently than every 65 seconds; hence, the need for report filtering to reduce the number of reports being displayed to the user or logged.) Originally, the daily log was created by the gateways being initialized to send traffic and routing reports every minute, although the log was updated only once per hour. Currently, the CMCC program polls gateway traffic and gateway routing reports every five minutes, and the log is updated every half hour. The recording interval is selected so as not to overflow the allocated disk space on ISIE.

With the gateway polling mechanism, the CMCC program will request and process reports from identified gateways at regular intervals. Both the list of gateways to be polled and the frequency of polling are user specified parameters. Hence, reports can be included in the display process and in the daily report log file from those gateways (such as RSRE, for example) which do not report automatically. Although data for the log file was originally collected by gateways being commanded to send reports automatically, with report filtering to exclude the extraneous reports, polling of all gateways is the mechanism employed currently. The reason for this change is that upon failure of the host computer on which the CMCC program is running, automatic gateway reports cannot be switched to another host computer. (Gateways do not implement authorization mechanisms to disable automatic reporting; the host computer that

has enabled these reports is the only host allowed to disable them.)

The "Which reports..." command format will now show how often the reports are being collected, polled, displayed, or logged, as appropriate.

Formats for two more report types, End-to-end statistics and Queue lengths, were added to the gateway reporting formats. With these additions, all report types from all monitoring gateways are now accommodated.

As an added convenience, the display program now gives the time a gateway was last heard if it is not being heard. This information allows the user to search the log file at a specific time for diagnosing problems. Also, the log file is closed after every entry, which allows the user to examine the log file in real-time.

We have acquired a new Pascal compiler from Rutgers University, which offers the following improvements over the one previously in use at BBN.

- Program execution is more efficient through use of a native mode operation which avoids the TOPS-10/TENEX/TOPS-20 compatibility package.
- Easier access to JSYS calls is provided.
- The capability of lower-case strings for display output is provided.

- Extended file handling capabilities are provided with features that permit random file access in the Pascal code directly without resorting to machine code.
- Multi-module programs can be debugged without multiple relinking with the Pascal debugger.

Modifications to the CMCC program sources for compatibility with the new Pascal compiler have already been implemented, and the new compiler is currently in service.

5.2 Facsimile

Two Rapicom 450 Computerfax systems and two DEC LSI-11/23 development systems, which will serve as part of the facsimile systems to be developed by BBN, were ordered and have arrived at BBN. Yet to arrive are the serial synchronous interfaces and the 1822 interfaces. The specific equipment list is given below:

EQUIPMENT	MODEL
Rapicom Computerfax Transceiver	450
Automatic Document Feeder	ADF-16
DEC LSI-11/23 Development System	SRWXSSA-BA
Dual Disk Drive UNIT	RX02
CRT Terminal	VT100
Serial Synchronous Interface	DUV11-DA
ACC DMA 1822 Interface	MLH-DH/LSI11

One Computerfax and one LSI-11/23 will be installed at BBN for developing facsimile systems. The other Computerfax will be stored temporarily at BBN, while the other LSI-11/23 was shipped to Dave Mills for him to use in experiments. Eventually both units will be delivered to ARPA.

6. MOBILE ACCESS TERMINAL NETWORK

As part of our participation in the Mobile Access Terminal Network (MATNET) project during the last quarter, we placed emphasis on the design and the fabrication of the satellite channel simulator. This work is described in section 6.1. In addition, section 6.2 describes the conversion of the Satellite IMP loader/dumper code for use in MATNET. Other significant accomplishments during the quarter are summarized below.

We obtained robustness cards from SRI International for both MATNET LSI-11 processors to improve the self-test diagnostic capability of the gateway and the Terminal Interface Unit (TIU). These cards will be installed into the gateway and the TIU before tests of these systems are performed.

The MATNET ACC 1822 Host-to-IMP interface boards were installed in an LSI-11 serving as a TIU for the Command-Control Network (CCN) project at BBN to test the interface and to exercise the TELNET and TCP protocols. During the test, this configuration was interfaced directly to a host port on IMP 1 of the RCCnet.

The specialized hardware for the Red/Black interface of the C/30 packet switch processor was designed. This hardware consists of a small printed circuit daughter board mounted above the C/30 universal I/O board for converting between the TTL

signal levels internal to the C/30 and the MIL-188C signal levels required by the COMSEC equipment. Additional circuitry to facilitate interface testing, including an extra input line and an extra output line, is also on the board. We anticipate that the spare output line will be used by the C/30 to generate trigger pulses for a logic analyzer, while the spare input line might be used to pass timing reference signals to the C/30. Manufacturing of this printed circuit has already begun.

During the last quarter, we also participated in the MATNET Preliminary Design Review held at ECI in St. Petersburg, Florida. In response to action items discussed there, we have begun a draft document of the MATNET test plan for phase 2B, and we reviewed the timing of signals being passed between the Black processor and the Red processor to verify that MAT stations are capable of filling the satellite channel under any arbitrary traffic specification.

6.1 Satellite Channel Simulator

The MATNET satellite channel simulator design was finished, and fabrication of a single unit is almost completed. This device reproduces the time delay resulting from broadcasting to a geostationary satellite. The selectable delays are 0 to 300 milliseconds in 1 millisecond steps to be inserted into the data stream, while the selectable channel channel bit rates are 9.6,

19.2, 51.2, 64, and 128 Kb/s. In all, four separate data sources can be combined; clocking signals at the channel bit rate are provided to all the transmitters and receivers while data are being transferred. A block diagram of the simulator is shown in Figure 6.1.

MATNET SATELLITE CHANNEL SIMULATOR

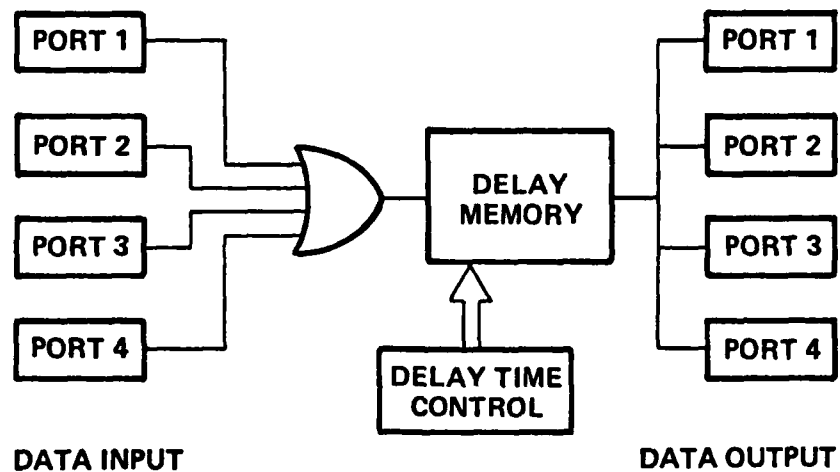


Figure 6.1 MATNET Satellite Channel Simulator

The MATNET simulator design is a derivative of the satellite channel simulator for the wide-band satellite network, where the channel rates are as high as 3 Mb/s. In the MATNET design, where the channel rates are only as high as 128 Kb/s, the internal systems clock is reduced by a factor of 5 to 5 MHz, and the memory is reduced by a corresponding amount. These changes

provide greater margin in the design tolerances, simplify the hardware, and reduce the parts cost.

In order to keep the design of the simulator simple, several aspects of the total system operation are not simulated. The principal simplification is in the handling of the Red processor control signals, Packet Type In (PTI), Go Signal (GOSIG), and Unique Word (UW). In the operational system, the Red processor indicates the length of a transmission by pulse-width-modulation of the PTI signal. The actual instant when a transmission should begin is marked by a transition on the GOSIG line. The simulator ignores the PTI line and requires the GOSIG to be on for the entire transmission time. Similarly, the Black processor will indicate the instant when a transmission is received by a transition on the UW line, while the simulator ignores this signal.

Other differences between the simulator and the operational system are related to the COMSEC and Codec equipment. The simulator does not add fill bits to the message and does not insert pauses in the output stream by stopping the receive clock. Thus, it will not be possible to check many aspects of the Red processor I/O code via the simulator. The intent, however, is to permit multiple Red processor testing to ensure that global synchronization of sites works properly.

For versatility and for providing a means of testing the simulator with proven Satellite IMP hardware, the unit is capable of serving as a satellite channel simulator for Satellite IMPs of both SATNET and MATNET. The unit has 12-pin Burndy connectors on ports with Bell 303 signal drivers and receivers for SATNET Satellite IMP interfaces and 37-pin Cannon-Cinch connectors on ports with MIL-188C signal drivers and receivers for MATNET Satellite IMP interfaces. Currently, the simulator has been tested successfully with the Honeywell 316 computer which serves as a software test-bed for SATNET Satellite IMPs.

6.2 Satellite IMP Loader/Dumper Conversion

During the last quarter, the Satellite IMP loader/dumper code was converted to be compatible with the 64K-word address space provided in the architecture of the C/30 packet switch processor which emulates the Honeywell 316 computer. (In the previous quarter, we had converted the Satellite IMP code itself.) The loader/dumper code comprises two separate stand-alone programs, one which uses the VDH host line as the access path and one which uses the satellite channel as the access path. The former is essential whenever the network is down, as is the situation when it is necessary to reload new software that is incompatible with old software, while the latter is essential for maintaining isolated Satellite IMPs.

Program conversion required the removal of all cases of multilevel indirect addressing and all instances where flags were placed in the sign bits of words referencing memory. (Before the words were used to reference memory, though, the flags in the sign bits were masked off.) Although testing of the code was performed on a 32K-word Honeywell 316 to ensure that program operation was not affected, true 64K-word operation must wait for delivery of a C/30 packet switch processor with enough memory and with the microcode to reflect the new architecture.

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